

Why should French tourism pay attention to climate change ?

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It is by no means original to recall that tourism is strongly conditioned by climate, be it in France or elsewhere (Harrison, Winterbottom. & Sheppard. 1999). The figures showing the importance of tourism in the economy -some 8% of the GNP, 75 million foreign visitors- suggest that the climatic modifications related to the greenhouse effect could positively or adversely affect one of the major activities of the national economy: a warmer climate could lead for instance some of France's foreign visitors to spend their holidays at home (Giles & Perry, 1998: 76-77) .

Global warming raises three issues this paper deals with, i.e.:

- a) the effect of climate change on the climatic and non climatic resources of tourism,
- b) the contribution of tourism to climate change (through transportation mainly) and
- c) the possible effects of mitigation policies on tourism.

Hitherto, research work has mainly dwelled on the first topic, for which we discuss the French situation which is rather complex owing to the geographical and climatic diversity of this country.

Tourism is affected by global warming, but it is also a major contributor to greenhouse gas emissions, by emitting CO₂, and other gas (mainly CH₄, N₂O), and through specific phenomena (contribution to the formation of cirrus clouds by airplanes for example). This point is less studied: research up to now mainly focused on the impacts of energy consumption, of transports etc. without assessing the specific contribution of tourism. The second part of the paper discusses the methodological and practical difficulties of such an assessment and gives some results drawn from French data.

Given the overwhelming importance of the stakes linked to global warming and a contribution by tourism which is far from negligible, this activity is bound to be concerned by mitigation policies. This is a broad issue which is largely ignored but needs to be explored, probably under various and contrasted hypotheses. The third part of the paper just points out to the importance of the problems which will have to be dealt with.

The effect of climate change on the climatic and non climatic resources of tourism,

As regards this first aspect, this paper calls for some preliminary warnings.

▪ What follows is based, as regards climate future on a scenario by Météo-France built for the French Mission on Greenhouse Effect (Déqué, 1998). The scenario considers the effects of a doubling of atmospheric CO₂ which could be reached by the middle of the next century. It concludes that France could know, compared to its current climate, a warming of about 2°C, more stressed in summer and in the south of the country. This warming would lead to an increase of winter rainfalls of about 20% (rainy events more frequent and more intense) and a reduction of summer rainfalls of about 15% (longer and more intense summer droughts resulting in a downfall of about 5 to 10% of groundwater reserves till autumn); these general tendencies would be more marked in the South than in the North (see the maps at the end of the paper). Since we are not qualified on the topic of climatic scenarios, we do not feel allowed to carry out a critical analysis of this scenario. It seems nevertheless useful to keep in mind that building regional scenarios (here the space resolution is 70 x 70 km) is generally regarded as a difficult task. This leads to a few questions:

- on the basic options of the scenario: the scenario gives regional results for a warming tendency, whereas experts tend to insist more and more on the possibility of climatic surprises: some authors talk about the possibility of a modification of the Gulf Stream which would lead to a totally different outcome than a 2°C warming (Duplessy, 1996; Duplessy & Morel, 2000);
- on the reliability of the conclusions that can be drawn, even if one admits the basic orientation of the scenario, in particular insofar as thresholds phenomena could exist¹.

Moreover, the scenario provides for each season results for average temperatures, rainfalls and water reserves held in the ground. It does not provide results for a certain number of factors conditioning as much as the previous ones tourism (cloudiness for example), nor does it give the results in the most relevant form for the matter we deal with (it is not so much the quantity of rain which is important but rather the rhythm with which it falls)². In fact, one cannot think only in terms of long term average climate change. It seems useful to distinguish “climate” from “weather” (Giles & Perry 1998:75; Department of the environment 1996: 200): the coming climate changes might be accompanied by a more frequent occurrence of extreme weather events and greater standard deviations to average conditions. The weather forecasts, now fairly reliable from one week-end to the next, allow short term departure decisions taking into account these deviations (Department of the environment 1996:..207). This faces some sectors of the tourism industry with a new challenge, in particular in Northern Europe where tour operators manage an important percentage of travel, but can be more easily coped with in a country such as France where the major part of tourism activity is external to the

¹ McBoyle and Wall for Quebec (1987) consider that the period for skiing, north of Montreal should not change as long as average warming does not exceed 2.2°, over 4° things worsen quickly

² The fact that the climatic variables acting on tourism cannot be reasonably limited to temperatures and rain quantities questions some current econometric models (MADDISON D. 2001. p 198)

market economy (Commissariat général du Plan 1998: 48)³. In such a context, domestic tourism might reveal itself more resilient than vacations abroad.

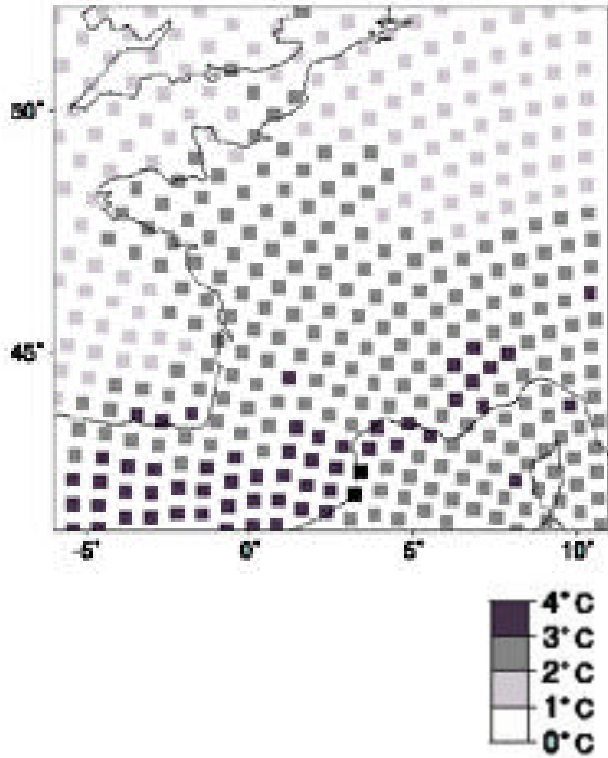
The benefits tourists will expect from climatic conditions in the forthcoming decades are quite uncertain. It is already known they vary largely according to historical periods and to the populations concerned. One can for example recall that the climatic requirements of the populations of the north of Europe are not the same as those of French people: the climate of Brittany will be better accepted by a British tourist than by a Frenchman for holidays, which does not mean however that the former will not prefer a sunnier destination. It is also known that the quest for sunshine is a recent phenomenon: Mediterranean people traditionally seek for shade, so did the British, developing summer hill stations in India. In France, a tanned skin, was not until recently much appreciated. Over one century the benefits expected from sea bathing completely changed and along with them, the requirements relating to the temperature of water. It is thus not unthinkable that new considerations, linked in particular to health (an increase of the number of skin cancers, on which TV and other media would undoubtedly dwell) could modify in a few decades the climatic expectations of tourists and question the heliotropism of our societies. On the French Riviera, for instance, changes can already be seen in the bathing habits of tourists, which tend to go to the beach sooner in the morning and later in the afternoon.

³ Nearly two thirds of the accommodation for the French taking holidays in France is provided by the family, friends or second homes (Secretariat d'Etat au tourisme 2000)

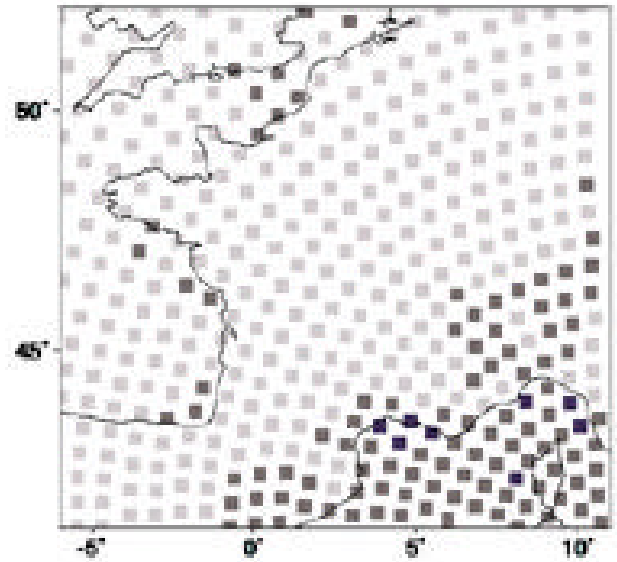
Impact of a doubling of CO₂ on French Climate

Temperatures

Summer

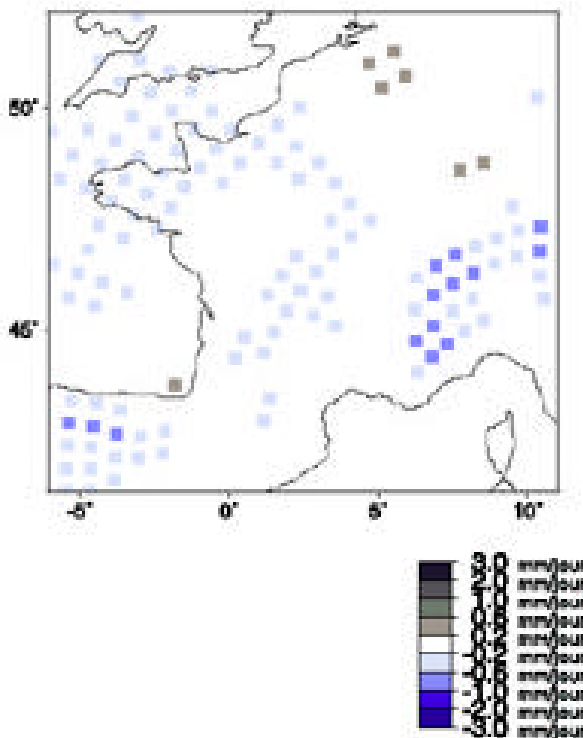


Winter

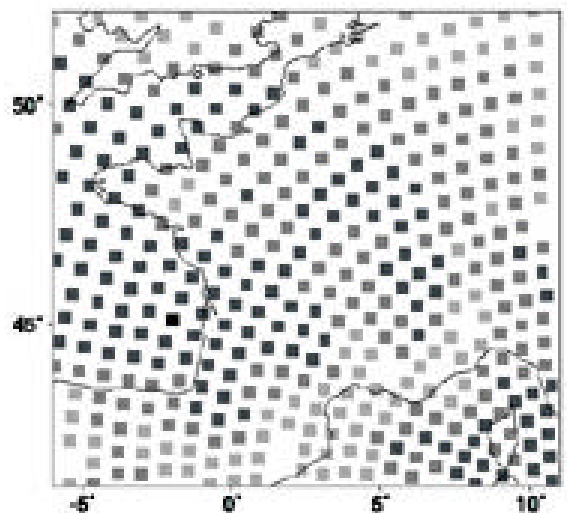


Rainfalls

Summer (diminution scale)



Winter (augmentation scale)



1) **Climate requirements of tourists and greenhouse effect** ⁴

A climate adequate for tourism should provide:

- **Safety.** It is important that tourists be sheltered from climatic accidents and the natural catastrophes which they generate, which is not always the case, since they are often more endangered than local inhabitants because of the proximity of water they seek and in reason of the fragility of some lodgings they use.
- **Amenities,** which includes several aspects:
 - *sunshine periods.* Which refers both to duration and regularity
 - *the absence of daily rainfalls.* It is not the quantity of rain which falls which matters the most, but the frequency of the falls. The limits of what is acceptable are subject to debates. These debates relate to a higher limit which, if one looks at the scenario of Météo-France, can cause worry for the winter season⁵, and to a lower limit which concerns the summer period: too dry weather presenting also disadvantages through its impacts on landscapes for example ⁶
 - *comfort* which comprises two aspects:
 - * thermal comfort. Considering the prospects the scenario points out, the higher temperatures can be a problem, in summer and for the hottest destinations. A fall of comfort starts to be felt beyond a daily maximum temperature of 31°C with a very significant aggravation beyond 33°C. On the opposite, one could hope that an appreciably more significant part of the country could remain, most of the year over the acceptable minima (16 to 18°C) and thus see its appeal for tourists enhanced. This might happen, but the diagnosis is much more complex and cannot be limited to taking into account temperatures which interact with the winds patterns and the percentage of moisture of the air. Moreover for the forms of tourism centred on bathing, the relationship between the temperature of the air and that of water is a crucial factor
 - * hydrous comfort: heat will be better accepted if the air is dry. From this point of view the scenarios associating a rise of the temperature of summer with diminishing rainfalls, are rather reassuring. On the other hand the increase in moisture in winter could degrade the assets of the France in this season and push tourists towards other destinations.
 - *the minimization of the major health risks associated to climate.* It is known that the exhibition to sunrays causes skin cancer, that the association of cold temperatures and violent winds increases the risks of heart attacks, and that moist winds increase cerebral and vascular accidents frequency. In this respect over-heated summers and more disturbed winters, are not welcome. Some categories of the population are particularly concerned (young children through dehydration...) but the main fact to take into account is the ageing of the

⁴ the main sources of the following paragraphs are : Besancenot 1989; Burnet 1970; Dewailly & Flament 1993 Escourrou 1993

⁵ The upper limit for winter should be one hour rainfall between 6am and 6pm

⁶ 4 days with rainfalls are considered by some specialists as an optimum (Burnet 1970)

population. More unexpected health hazards affecting tourism might arise; malaria cases have been mentioned around French airports: a warmer climate might favour this kind of disease which in the previous centuries was frequent in some parts of France.

One is thus far from a simplistic vision of the consequences of a climatic change, according to which one would consider that two degrees more, and a more sunny situation, would reinforce the assets of France, or Britain (Nuttall 1996), for tourism. The situation is more complex and the results provided by the scenarios hardly make it possible to reach a clear diagnosis: a vision of the temperatures and rainfalls is not sufficient: data, or assumptions if building scenarios is the aim, are necessary in the fields of nebulosity, the rainfall and winds pattern etc.

2) Climate change, seasons and regions

▪ **Summer.**

The western regions of Europe profit from a oceanic climate which answers tourists expectations during 30% of the summer to 70% as one moves southwards. One could think that a warming climate could at the same time lengthen the season and allow tourist practices to expand towards the north. One can recall that the difference of average temperatures on the Atlantic coast between the 48th parallel (Brest) and the 46th (Oléron) is about 3c °in August, that is to say a little more than the rise of the summer temperatures in the scenario. The inland warming would be of the same magnitude as on the coast, which could contribute to improve the tourist potentialities of the lower mountain regions: a difference in altitude of 400m can imply a difference in temperature of 2 to 4°C

The Mediterranean climate is currently unquestionably favourable to tourism during the four summer months. It is in fact rather adapted to a mass tourism which is more sensitive to sunshine than to real comfort. The changes envisaged by the scenario could accentuate this vocation of Mediterranean France to accommodate a population in good health, ready to accept excessive heat. As a tourist destination, the Mediterranean coast of France would undoubtedly be rather less affected than Spain or Greece, already hotter (Viner & Agnew 1999: 21-23); for this reason it could profit from a comparative advantage compared to nearby destinations of same type. Greater heat is also likely to repel at the same time the important old age population and the residents of Mediterranean regions, in France, Italy or Spain. Thus, mountain regions could become appreciated for their relative coolness, the shade of their forests...

▪ **Winter.**

Currently one can express serious doubts on the winter tourist vocation of the Atlantic coast, not so much because of the temperatures than of the constant lack of weather stability. This point is all the more important since the customers available at that time are essentially old age pensioners. Looking at the local intensities of winter rainfalls of the Météo France scenario, it does not seem that the situation should improve on the coast, nor inside the country : the average temperate climate is likely to become less favourable to winter holidays than it is now. Some places are favourable to winter holidays on the south Atlantic coast, but that is due to microclimatic conditions, and one can wonder whether they will resist the announced

variations. Even if these privileged sites are rather small, from the economic point of view the stakes are important: what will be the winter like in Biarritz in 2030?

One can also doubt that the Mediterranean coast sees its situation as a winter vacation resort improve radically. The reputation of the gulf of Genoa and its back country is well established, but a glance on its climatic data shows that it is really privileged compared to other Mediterranean areas (strong homogeneity of the fresh season). In France itself, the climate becomes more disturbed and windy in Western Provence and in Low Languedoc, which are not so well suited for winter holidays. Even if rainfalls are expected to increase less here than on the Atlantic coast, it does not appear likely to improve the situation.

Consequently one can wonder whether large cities, where climatic environments are controlled, will not see their attraction increasing in winter. In the same way the completely artificial resorts such as tropical leisure parks could expand.

▪ **Shoulder seasons**

The tourist potentialities of spring and autumn could at a first glance be largely increased. This could meet with current phenomena like the development of short vacations, insofar as this trend continues. In fact the future prospects are not so clear... For the Atlantic coast and its inland regions, the Météo-France scenario forecasts milder springs but increased rainfalls. If that means more disturbed weather, one does not see what tourism will gain from it. On the other hand, one can expect excellent dry autumns. Logically the tourist season should last longer, rather than start sooner, unless gloomier winters and contrasted springs result in massive departures with the first sunny days. In fact, this can be seen nowadays for the Mediterranean area: objectively the autumn climate appears more favourable to tourism than spring and yet springtime seems more appreciated by tourists. In addition one can wonder whether the landscape of a dry autumn, consecutive to the strong hydrous deficits of summer will not spoil the end of the season: a country like Greece has the reputation to be appreciated more in spring than in autumn.

Ultimately, the evolutions envisaged by the Météo-France scenario could reveal a divide between regions/seasons favourable for a type of tourism adapted to people in good health which can deal with some climatic stress, and others, more adapted to an older and more fragile population. The reaction of the various categories of customers to these modifications of climatic conditions possibly will not be immediate nor mechanical. In addition, the climatic trends will undoubtedly modify the comparative advantages between France and neighbouring countries; it is an important issue that the scenario, which solely deals with France, does not point out.

3) Impact of global warming on the non-climatic resources of tourism

▪ **The energy consumption of lodgings**

The climatic conditions can strongly influence the building and maintenance conditions of lodgings and tourist infrastructures; it is known for example that hot and wet climates damage buildings... In a country such as France, one can think that the future climatic conditions could facilitate the use of light lodgings in season: camp-sites and

intermediate forms of lodging, providing that these types of accommodation are reasonably comfortable even under excessive heat. Moreover the rise of the temperatures could foster a request for air-conditioning⁷ - which is already increasing dramatically - the more as it meets the interests of supply-side stakeholders (surpluses of electric production from nuclear power stations in summer); the energy consumption of tourist activities could thus be deeply modified.

▪ **Beaches and sea level**

It is not the rise in the sea level which is the most worrying: the concern is far from being same importance as for the tourist destinations in the Pacific (Maldives and others: Viner & Agnew. 1999:17). However, one can remind that France faces a slow increase of the sea level, from 1,2 to 1,5 mm a year owing to long term phenomena (Simon 2001: 8); the greenhouse effect should accelerate this phenomenon which contributes to coastal erosion (Paskoff 2001: 14-15). Out of 5500 km of coasts 850 are subject to an average withdrawal of more than one meter a year; the sand beaches roll back or disappear in certain places (30 m withdrawal in Flandres and 450m at Saintes Maries de la Mer in a half century) (Ifen 1994: 27), 20% of the French coastal communes currently have their beaches attacked by erosion (Thorette & Marchand 1996: 93). A reasonable option is to do with the phenomenon, which implies not to build, too near the coastline, commodities that will call for further protection. It must also be reminded that sand beaches might move back without disappearing, which is the case for the shoreline south of Bordeaux since Roman times. The other option which is to resist includes two possibilities:

- building protections along the shore (already 400kms in France)
- compensating the diminishing sand volume, which maintains the landscape and is not so costly as one may fear. The Dutch bring back each year to the shoreline some 6 or 7 million cubic metres of sand for a cost of 35-40 million dollars. The quantity forecasted for 2100 should increase by 50%. It remains that currently the maintenance of a kilometre of sand beach costs less than the maintenance of a kilometre of motorway (Paskoff 2001: 18)

▪ **Water resources**

The scenario of Météo France provides charts concerning the water reserves of the ground. It points out to a strong contrast between spring (capitalizing the rains of winter) and the rest of the year. It is not possible, in this paper, to appreciate the impacts on the vegetation and the landscapes of France, and consequently on numerous amenities on which tourism is based⁸. It remains to see up to what point the new situation would modify the comparative assets of the various regions by giving a advantage to those that would remain relatively green the summer and in autumn, for example the north east of France (Jura, Vosges) where the impact would seem to be lower. In addition, it is probable that on the whole territory, the water supply for tourist activities and leisure would be harmed and that one should see more and more frequent restriction measures which have appeared these last years and which can adversely affect family tourism and more still second homes (watering of the lawns, swimming pools...).

⁷ The air-conditioning of a hotel requests from 90 to 150 kwh/sq metre

⁸ A detailed analysis of this issue can be found in WALL G (1998), though the author refers to a North American context.

It is of course for the Mediterranean part of France that one can be most anxious. Among Mediterranean countries, French river basins enjoys a privileged position (Margat 1990) Whether one considers the part of resources that are used or net consumption, France is in a good situation, compared to its developed neighbours (the situation of south Mediterranean countries is far worse); in addition expected demand for 2025 still leaves a margin for additional use. The water demand related to tourism is however badly known: the demand of tourist activities is considered as a part of that of communities, of which it would represent about 10%... For Mediterranean France, communities themselves account for 10% approximately of the total use. In terms of use, the industrial sector comes first (cooling of power stations which hands back water after use) whereas in terms of consumption agriculture accounts for 85% of the total. It should however be specified that consumption related to tourism is concentrated within the period when water is rare (it is also the case for agriculture). That leads to the necessity of over-sizing the storage facilities (at some economic cost...) and possibly in the future, to choices between uses for tourism and irrigation (roughly the consumption of a square meter of lawn is of the same order as that of a square meter of corn). Choices within tourist activities might also have to be made (see for example the questioning of water consumption by golf courses). Important savings potentials exist as well for irrigation as for tourist activities.

Lastly, it goes without saying that drier summers will increase the risks of forest fires in the Mediterranean regions (Viner & Agnew 1999, p 24) and elsewhere, causing safety problems and spoiling much appreciated landscapes

▪ **Snow for winter sports**

This is an issue which has been studied in France and abroad (Mc Boyle & Wall 1987). We shall just briefly point out the conclusions of Eric Martin for the French mountains (Martin 1996). This author assesses the impacts of a rise of 1,8°C, without taking into account any change in the total of rain and snow falls.⁹ At an altitude of 1500m E. Martin evaluates the reduction of the duration of the snow cover from 20 to 25% in northern Alps, of 30% in the part of the southern Alps staging from Dévoluy to High Tarentaise and Queyras, of over 40% for the more southern part of the Alps and up to 45% for certain regions of Pyrenees. At higher altitudes the reduction in the time the snow cover lasts would be only 10%. One can easily imagine to what point the conditions of winter sports would be upset.

⁹ This is somewhat in contradiction with the Météo France scénario which expects more snow/rainfall in winter or in spring on the mountains.

An assessment of the contribution of French tourism to global change

Within an environmental assessment of the tourism sector at a national scale, we conducted for the French Institute for the Environment (Ifen), an evaluation of the contribution of tourism transport to global warming. It is all the more important for the tourism sector to be aware of these figures as tourism is both highly and increasingly dependent on transport. Future transport policies could have a strong impact on tourism development.

1) Hypothesis and methodological choices

In order to simplify the evaluation, and taking into account the reliability of data, it was decided :

- to take as a starting point the tourist himself rather than the economic activities related to tourism (i.e. to privilege a consumption approach rather than a production approach). Therefore, the impacts of sub-sectors, such as travel agencies, or the operating of air companies (independently of the air trip itself), are not included in this assessment ;

- not to get involved in a life-cycle approach. In such an approach the impacts of the construction and destruction of air planes, hotels, equipment or energy plants should be added, as well as the impacts of implementing «clean» energy production processes . This is why we only considered direct contributions to global warming, and left aside indirect ones;

- to evaluate, tourism impacts at a national level rather than at the destination level. Much research on environmental indicators for tourism is destination-oriented (Ceron & Dubois 2001), whereas the Kyoto protocol on the reduction of greenhouse gas emissions refers to a national basis. Therefore, a national evaluation was considered as necessary to define the priorities ;

- to calculate a *total* contribution rather than a *net* contribution to greenhouse gas emissions. If a tourist stays at home instead of spending vacations, he consumes water, and energy, produces wastes and greenhouse gas which should be subtracted from the total tourism impacts in order to calculate the net emissions due to tourism. On the one hand, *total* estimates are most appropriate to establish benchmarks, or to facilitate regional or place-based analysis (EPA, 2000). They do not depend on the variability of alternative activities, which may change over time and places. On the other hand, *net* estimates are useful to point out what is environmentally friendly in a tourist's way of life, compared to everyday life (staying in a camp site for instance), and what is not and leads to an over consumption of resources (using air planes, ski lifts...). At home, households also contribute to greenhouse gas emissions, through personal or professional movements; however, in the case of transport, net emissions seem very close to total emissions, since the distances travelled are much more important during vacations.

- to evaluate only the contribution of tourism transportation to global warming. The main components of the tourism product/experience are transport, lodging and

catering, the use of equipments (ski lifts, swimming pools, etc.), and activities (i.e. walking, swimming, etc.). More generally speaking, the impacts of tourism on the environment can be parted between on-site impacts (including on-site transports) and transportation (to the destination) impacts. Each step of this consumption pattern contribute to global warming and, legitimately, should be evaluated, though it is not the case here.

Calculating the total contribution of the tourism sector remains uncertain because of the lack of required data. The methodology for accommodation and equipment would require a knowledge of the number of overnight stays/visitors for each type of accommodation/equipment, allowing to multiply by ratios, such as the average use of energy per overnight stay/visitor. The breaking down between the different energy sources used (electricity, fuel, gas....) should be known to calculate greenhouse gas emissions. ¹⁰

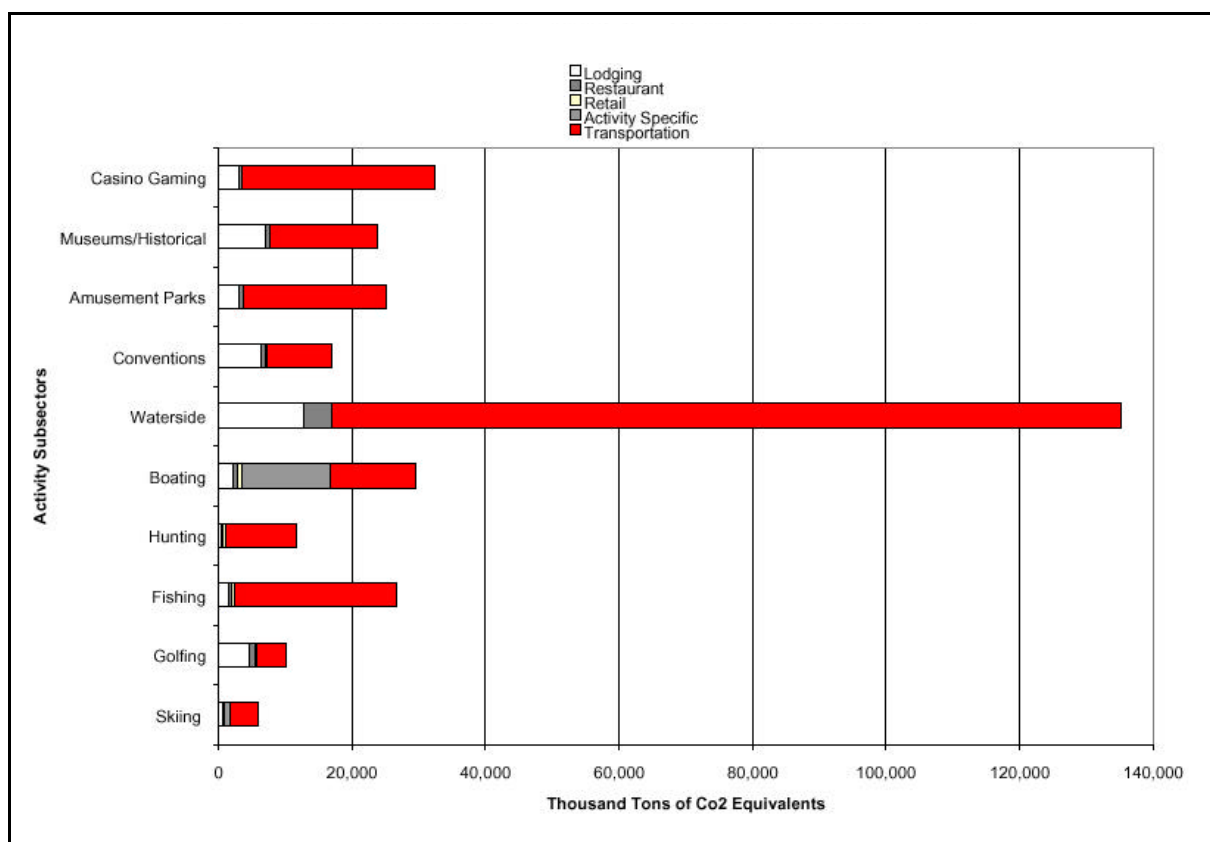
- for accommodation, these ratios depend on the standard of comfort, the age of accommodation, the climate of the location (implying air conditioning, heaters...). This is why data based on local surveys are not very helpful. Only a few surveys provide such ratios for hotels, camp sites, secondary homes on a national basis...Current research on eco-labelling and its forthcoming monitoring will provide more ratios in a nearby future;
- there is also a great lack of data concerning equipment: very few data are available for theme parks, water parks... *Ifen* estimated from 571 to 734 GWh the energy consumption of 4000 lifts during a casual winter season, e.g. from 1/4 to 1/3 of the annual energy production of a nuclear plant ;
- further, when lodging, catering and equipment are included in an overall evaluation, it seems necessary to consider both *total* and *net* impacts on climate change. It would not be fair to the tourism sector to just consider the *total* estimate. One should rather focus on the incremental emissions caused by tourism, and on the way of reducing them.

This is why the idea of an evaluation of the contribution to climate change of the overall tourism activity was abandoned.

Concerning transports, in spite of a considerable amount of research devoted to the environmental impacts of day-to-day household travel, until recently only little work, specifically focused on the environmental impacts of household *tourism* travel. According to OECD, «*One source of tourism-related environmental impacts – travel – remains consistently and conspicuously absent from the general discourse on sustainable tourism.*» (OECD, 2001). With regards to global warming, the evaluation of transportation impacts should be considered as a priority: the Environment Protection Agency (EPA, 2000 see Figure 2), estimated that for the United States, 76,5% of greenhouse gas emissions of the tourism and recreation sector are caused by transportation (against 15% for lodging, 2,7% for restaurants, 1% for retail, and 4,8% which are activity-specific). On-site travels usually have a lower impact than the travels from home to destination. In Calvia (Balearic Islands) on-site tourist movements represented 73 000 tons of CO₂ in 1995, when air transport to the destination contributed eight times more to greenhouse gas emissions (534 000 tonnes).

¹⁰ As far as electricity is concerned, it is possible to convert energy consumption into greenhouse gas emissions thanks to national data on electricity production and its splitting between sources : coal, nuclear, renewable, etc.

Figure 1: Total CO2 Equivalent Emissions for Selected Activity Subsectors



Source: EPA, 2000

2) Results

A detailed methodology referring to data sources and their use is provided in Appendix A

▪ Estimation of the total contribution of tourism transport

The first result is the important contribution of tourism to the emission of air pollutants: the contribution of tourism to road transport emissions (Figure 3) varies from 6% for COV, to 26% for Nox.

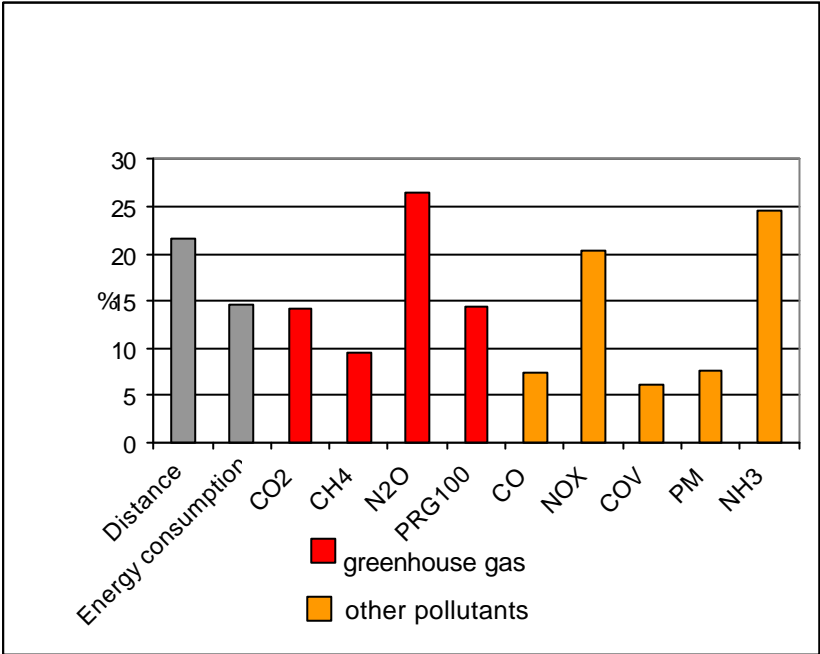
Compared to the French overall emissions in 1994, the contribution of domestic tourism is negligible for methane (CH₄: 0,1%), which mainly comes from agricultural sources, or ammoniac (NH₃), but is still important for air pollutants such as carbon monoxide (CO: 4,1%), nitrogen oxides (Nox: 11,8%), light organic compounds (COV: 2,4%) and carbon dioxide (CO₂: 5,5%).

Domestic tourism road transport represents (Figure 4) 24% of personal vehicles emissions of CO₂, 14,7% of road transport, 12% of the overall transport sector, and 5,5% of French emissions. It reaches annually 105 billions of km and emits 17 millions of tons of CO₂. *The potential of global warming (GWP100) of domestic tourism road transportation accounts for 3,8% of French total emissions (4,8 million tonnes carbon*

equivalent). The total contribution (domestic and international tourism, all modes of transports included) is about twice more important, from 7 to 8% :

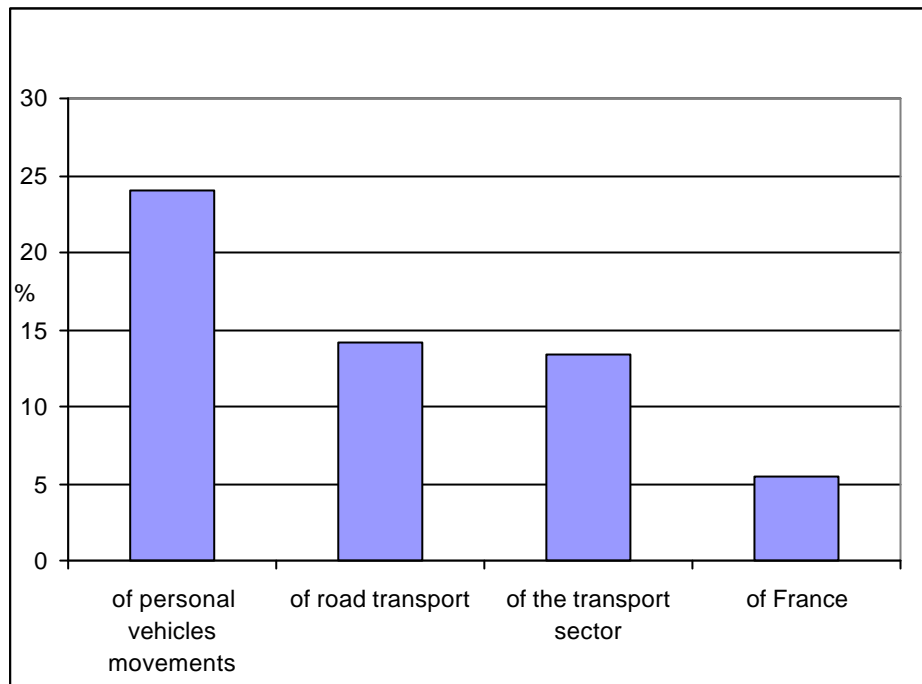
- air transport for domestic tourism reaches 15% of the distance travelled by road for tourism purposes, with emission per passenger.km from 2 to 4 times more important. This leads to a rough estimate of 45% of domestic road tourism transport.
- rail transport for domestic tourism represents 20% of the distance travelled by road, with emissions per passenger.km 3 times less important (*National Transport Survey*)., thus about 7% of domestic tourism road transport emissions.
- international tourism travel to France represents 30% of domestic tourism travel, with more air travel than domestic tourism. This comes up to, at least 45% of domestic tourism road transport emissions¹¹.

Figure 2 : Contribution of domestic travel to greenhouse gas emissions of road transport



¹¹ This figure is surely underestimated, owing to far distance travel.

Figure 3: contribution of domestic tourism road transport to CO2 emissions of...

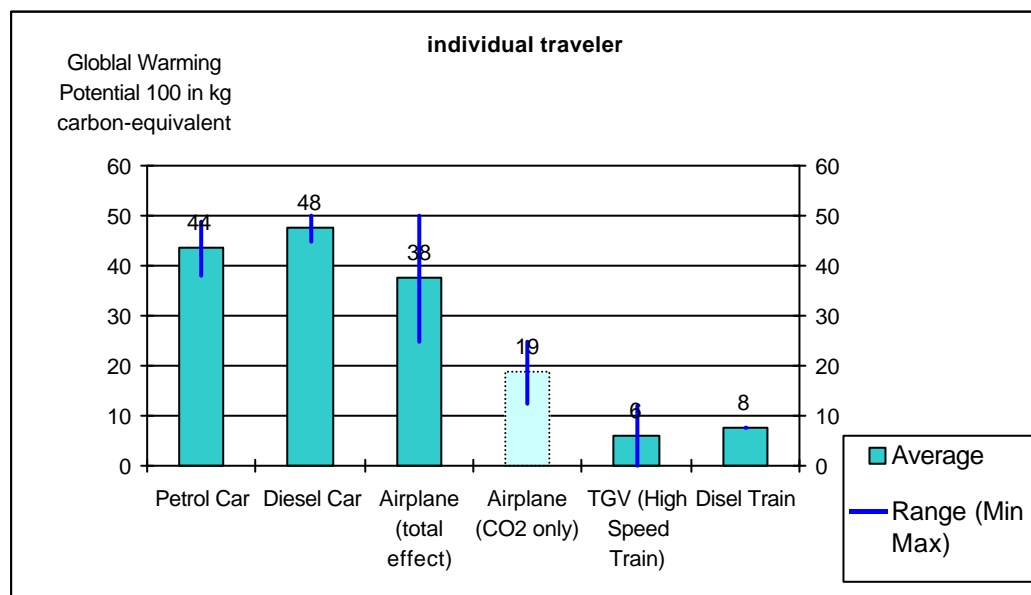
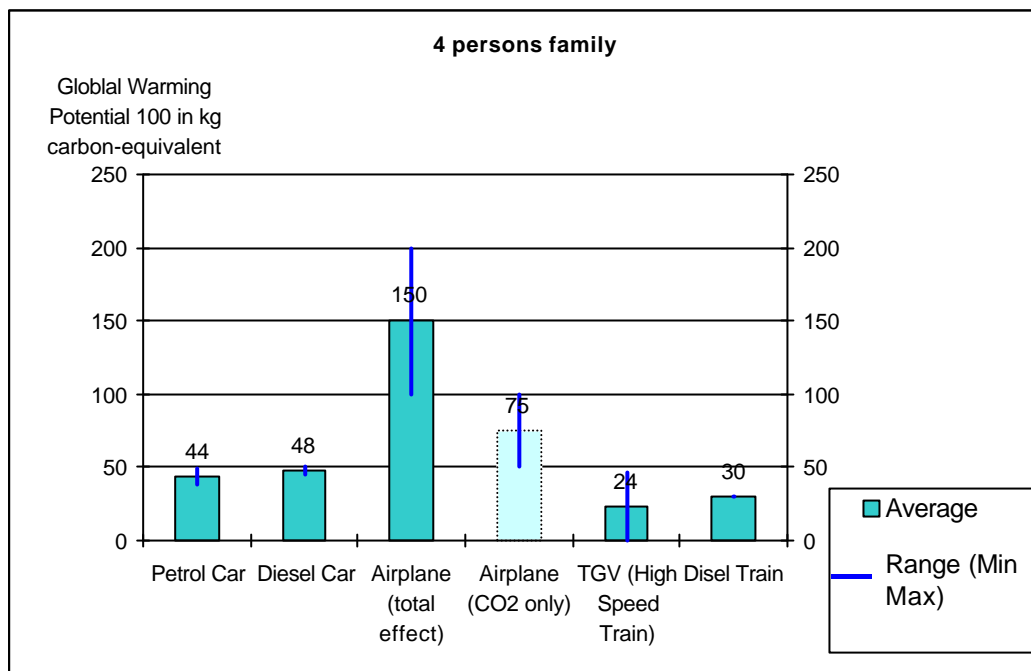


Source : IFEN based on SNCF, European Environment Agency (Copert III and MEET programmes), IPCC, Airbus Industries, EDF

▪ **Estimation of greenhouse gas emissions for a specific travel**

In this example for a Paris/ Nice trip, a family will have contributed three times more to global warming with an airplane than with a car, five times more than with a train. In the case of an individual traveller – responsible for the total of the car emissions, but only responsible for one fourth of the airplane and train emissions calculated for a family – airplane and car emissions are almost equal. In all cases, the train is the winner of this competition, with very low emissions when the electricity comes from nuclear or renewable sources. For that range of travel distance, air transport represents 2% of personal trips taken in France, the train 18%, the cars 80% (*Insee, National Transports Survey*).

Figure 4: Impact on the greenhouse effect of a journey from Paris to Nice, depending on the mode of transport



Source : IFEN based on SNCF, European Environment Agency (Copert III and MEET programmes), IPCC, Airbus Industries, EDF

Remarks. Range : from the most to the least polluting vehicle in each category.

Cars. Variables : age , horsepower , type of journey (motorway or main road)

Planes. variables : type of aeroplane. Two estimations are given: one for the effects of carbon dioxide (CO₂), which are well known, and the other for the impact on the greenhouse effect of all pollutants emitted during the flight ; In this case, the effects of nitrogen oxides, water vapour, sulphur oxides and jet trails are all taken into account .

Trains. Variables :type of energy used to produce electricity for a TGV , from hydraulic power (0 or near 0) to coal (47)

Transport has a growing responsibility in greenhouse effect : the contribution of transport in French CO2 emissions climbed from 8% to 39% between 1960 and 1990 (*Citepa*). The modal choices (and consequently the infrastructure choices) have a strong impact on this contribution. This issue is all the more important for tourism as it is highly dependent on transport.

The dependence of French tourism on transports

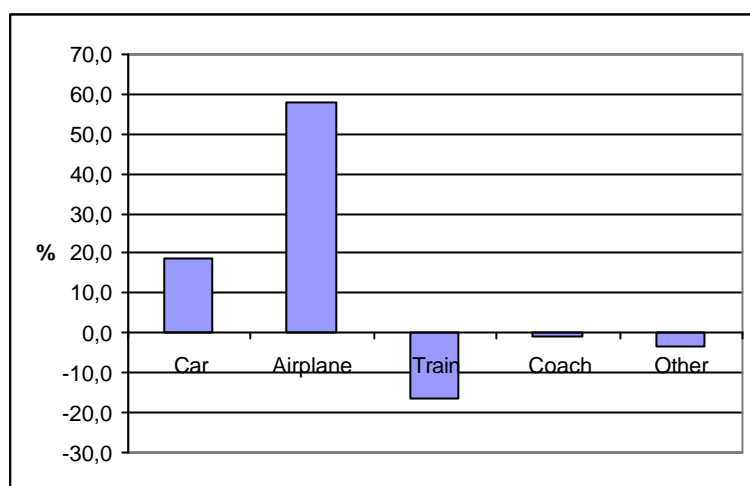
1) *The growing transport intensity of French tourism*

By nature, tourism relies on transport but it also does more and more. Rather than the growth of overnight stays, the changes in households travel behaviours is the main reason for the growth of tourism mobility in France. Current trends show that greenhouse gas emissions follow the increase in mobility. Moreover, it can be expected that they will grow even faster because of the evolution of the modal partition of tourism departures.

Tourism and transport surveys show more frequent departures, for shorter stays and longer distances. The recent French law on the reduction of working time (« 35 heures »), adopted in 1999, will certainly reinforce this trend, since it enables more departures and shorter stays. In short, the same activity for hotels, restaurants... requires more transport than it used to:

- from 1979 to 1999, the number of overnight stays in France by French tourists staggered from 733 millions to 709 millions (-3%), whereas the number of departures (i.e the number of tourist trips) increased from 43,8 millions to 62,1 millions (+ 41%) (Insee, « Vacances » Survey).
- The average length of stay for a French tourist dropped from 18 to 12 days between 1975 and 1999 (Insee, « Vacances » survey)
- the number of personal annual departures rose from 3,1 to 4,8 between 1982 and 1994 (Insee, Transports Survey), and is staggering around 4,5 in 2000 (SDT Survey).
- The average annual distance travelled for personal long-distance trips (>100 km), is 5230 km per person, whereas the average length of one personal trip is 1430 km (SES, 2002)

Figure 5: Evolution of the modal repartition of holiday departures (> 4 nights), 1986-1999



Source: Insee, «Vacances» survey

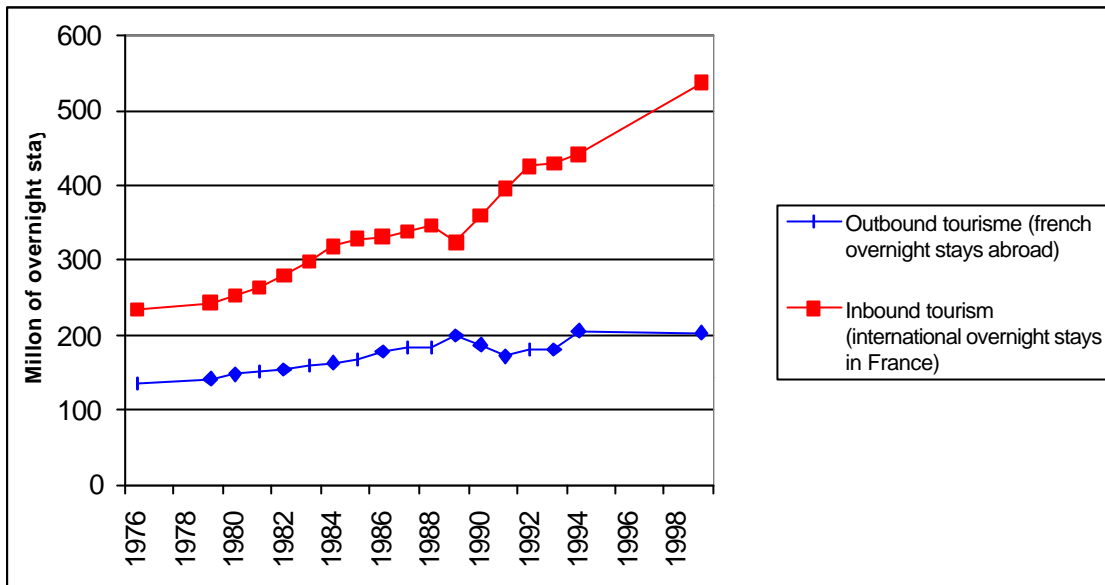
The contribution of French tourism to greenhouse effect will increase even faster than the number of departures, since, as Figure 6 shows, the most polluting modes of transport (airplane and cars) take a more and more important share in departures. French tourism seems structurally dependent on road and air transport. The attitude of tourists to transports, the spatial distribution of resorts within France, past infrastructure choices (highways rather than train service), and current trends of the tourism demand (the attraction of French tourists for remote areas, etc.) lead to this high-impact situation.

2) The dependence on air transport

French tourism is a healthy economic sector. However, its growth relies on inbound and outbound (international) tourism. Outbound overnight stays increased by 32% while departures increased by 76% between 1979 and 1999. Meanwhile, inbound overnight stays increased by 104% (Survey «Enquête aux frontières»).

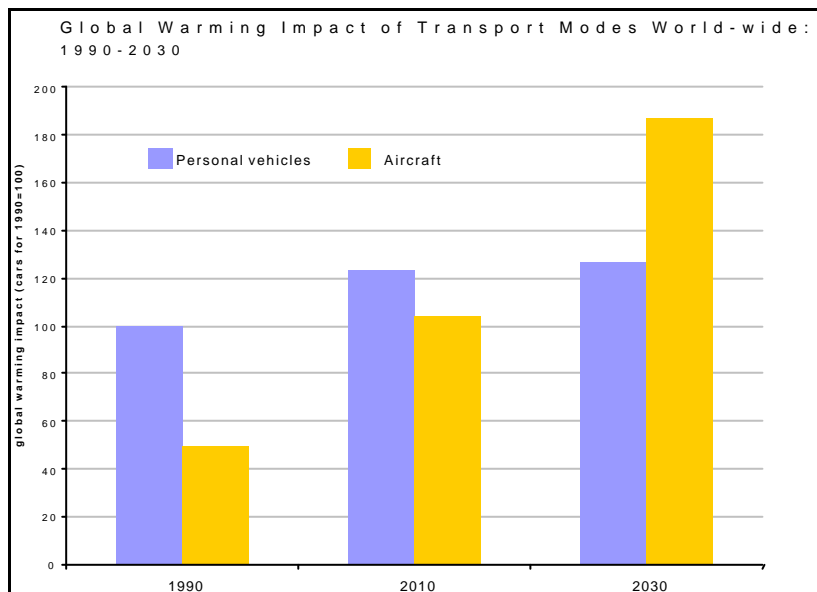
Contrary to remote areas (such as islands), France benefits from the proximity of other European countries (main international markets). This is why 57% of Foreign tourists used their car to reach France in 1996. However, international tourism remains strongly dependent on air transport: 44% of French departures to international destinations (including French territories) use planes (SDT Survey, 1997), so do 15% of international arrivals to France («Enquête aux frontières» Survey, 1996)

Figure 6: Evolution of international tourism to and from France, 1976-1999



Source: «Vacances» Survey and «Enquête aux frontières» Survey

Figure 7 : The growing impact of Aircrafts on Global Warming



Source : CST 1999, IPCC 1999, OECD, 1995

3) The dependence on road transport

For various reasons, French domestic tourism also relies on road transport :

- the French tend to organise their holidays themselves more than their neighbours do, and Tour Operators (which are more likely to use collective means of transportation, be it coach, train or plane) only hold a low market share;
- rural tourism accounts for one third of domestic tourism. It is obviously more difficult to provide a coach or rail service in rural areas than in

- waterside or urban resorts (87% of stays in rural areas use car, against 73% in urban destinations).
- especially on the coastline, tourist lodgings are spread over the territory rather than concentrated in centre cities.

4) The dependence of tourism on future transport policies

Tourism contributes significantly to the greenhouse effect, and relies more and more on transport: these two statements show the sensitivity of tourism to future transport policies in the context of a reduction of greenhouse gas emissions under the Kyoto protocol, and furthermore in the context of more restrictive transport policies which might emerge in the future.

The last part of the paper explores two contrasted scenarios taking into account these prospects.

The first is based on a maximalist interpretation of sustainable development which will consider that the right to emit greenhouse gas should be equally shared between all inhabitants of the planet. The second takes as a starting point the states' commitments, namely the Kyoto protocol on greenhouse gas ; this second point of view is far less demanding in terms of equity than the first one. Below we explore the consequences of these two approaches for tourism.

▪ A maximalist perspective

Let us first examine the consequences of focusing on the equalitarian dimension of sustainable development .

One can take as a starting point the work of a team including amongst others H. Opschoor, E. Von Weisacker, R. Petrella and R. Ayres ; According to these authors, the respect of ultimate environmental constraints (with a stabilisation the Third world population at twice its present level) would suppose a reduction of environmental impacts by an order of magnitude ranging from 10 to 20.

It is known that the number of tourist stays of French residents has increased threefold since the middle of the sixties ; dividing it by ten would bring back to a pre-war situation. Clearly with such hypotheses, no tourism remains possible.

One can also take as a starting point the impact of tourism on climate warming. The use of energy generates roughly 6 billion tonnes carbon equivalent for some 6 billion people. In a equalitarian perspective, this would lead to a right to emit greenhouse gas of about one tonne per individual, (less with an increasing population), if one just tries to stabilise emissions which is far from guaranteeing the respect of ultimate environmental constraints. Since the global warming potential of domestic tourism is somewhat over 5% of the global French contribution, the question is : what could each of us do with the quota of 50kg carbon equivalent it could devote to his travelling for tourist purposes. Figure 5 shows that this quantity is a little more than the cost of a travel from Paris to Nice, and only allows to come back the following year.

Such an approach might be considered as extremist. The theme of an equalitarian access to resources is nevertheless supported by groups of intellectuals both in the North and in

the South ; one can also recall that radical discourses might be listened to¹² , especially when they meet the frustrations, the lack of perspectives large groups of population are confronted with.

- **A minimalist perspective**

The second type of approach consists in abiding by the commitments that have been taken by the states, however far from the equity principle previously put forward they may be. By signing the Kyoto Protocol, France has committed itself to bring back its emissions to the 1990 level. This is the first step towards reducing emissions in the long run, at a moderate rhythm. In this case also, it is worth while looking at how an expanding tourism activity can cope with such prospects. Naturally this issues concerns France and Europe where growth prospects are moderate, but also other regions of the world where tourism is expanding at a much higher rate. According to WTO forecasts international tourist arrivals should almost treble within the two next decades and by 2020, 1.6 billion tourists should travel to foreign destinations. The growth should be more moderate in Europe with a growth rate of 3% and 717 million visitors¹³

France is not in the worst position to maintain its greenhouse gas emissions at a constant level, nevertheless tourist mobility follows an upward trend . How can this problem be dealt with ?

To what extent can productivity gains, which diminish the quantity of energy used per kilometre, help ?

As far as cars are concerned , for a given category of vehicle, gains around 25% in energy consumption are expected in the next decade; this gain will be partially offset by safety requirements which increase the weight of cars, and by the consumption of more frequent air cooling equipment. This figure can also be compared to the 31% and 38% increase in holiday and week end distances between 1982 and 1994 (Insee, transport survey)

As far as planes are concerned, the decrease of energy consumption per passenger.km is roughly 25% from one generation of planes to the next (every 25 years).Before the next technological leap occurs (use of liquid hydrogen), the gains are likely to be less important than previously. OECD believes that during the next twenty years, the contribution of air transport to total greenhouse gas emissions due to energy use will increase from 3% to more than 7%. At world level it could, somewhere between 2010 and 2030, catch up with that of road transport. One can remind that the number of holidays taken by the French in a Foreign country increased from 3.8 to 11 million between 1964 and 1994 (Insee "Vacances" Survey) and that the figure of personal trips of the French, using air transport increased by 16% from 1996 to 2000 (Direction du tourisme , SOFRES, SDT¹⁴ survey). French tourists cross the border far less frequently than their neighbours of north-western Europe, but nothing indicates that it will continue.

For air and road transport, technical progress does not permit to offset the effect of the increase of tourist movements and it seems it will be even less the case in future decades.

¹² See, for instance the maximalist interpretations of the precautionary principle

¹³ Report by the Secretary General of WTO. « Développement durable du tourisme » Contribution au sommet de Johannesburg 2002, p 9.

¹⁴ Suivi des déplacements touristiques des français

To mitigate such alarmist assessments, one can remind that all types of movements are not equally useful or that people can choose to privilege one type of travel to the detriment of another. Multiple trade-offs are possible providing the huge stakes or problems they imply can be dealt with. Clearly this means, for a given volume of trips to choose between tourism on the one hand and other types of trips : home to work, professional trips, daily trips etc. on the other hand . At a upper level, the choice is between transports and other uses of energy. These trade-off possibilities are to be considered seriously ; work is currently done on the instruments supposed to manage them : debates on a carbon tax or on tradable emission permits. Already the environment committee of the International Civil Aviation Organisation, admits it will be necessary for air transport to enter such negotiation processes and buy tradable permits to continue expanding. Though the prices on a market are only know ex post, some hypothetical prices for a tonne of carbon can be quoted ; they vary drastically according to the hypotheses made on the characteristics of the market, and the countries that would accept to get involved.. Figures, considered as serious can rise over 200 per tonne ; in that case the emissions of a trip from Europe to the west coast of the USA and back would be valued at a level of 150 euros. This marginal cost would imply a lower increase in average cost and thus in the price of fares

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Appendix A. Detailed methodology

1. Estimation of the total contribution of tourism transport

We first calculated emissions of greenhouse gas related to domestic tourism by road transport, for which very precise data were available ; then we extended our investigations to the whole of tourism transport, taking into account the modal distribution of domestic and adding international tourism to France; we finally calculated average emissions factors per passenger.km for road, air and rail transport.

Evaluating the contribution of domestic tourism road transport to global warming required very precise data concerning tourist movements (kilometres), and emission factors for various pollutants. Some very consistent data are available for road transport, thanks to the National Transport Survey, for 1994. Households were asked to part their annual road trips (in kilometres) into five categories: home to work; professional trips; *week-ends*; *holidays*; others private trips. The selected categories do not exactly match with a definition of tourism, since some week-end trips can be undertaken without an overnight stay. They do not match either with recreation, since the category «other private trip» (including daily leisure trips) has not been taken into account. The survey enabled to determine which type of vehicles were used for the different types of trip (petrol or diesel, age and capacity of vehicles), which is important since holidays and week-ends trips appear to use more frequently diesel engines, more recent and higher capacity vehicles.

The emission factors per kilometre were provided by the Copert III program (Computer program to calculate emissions from road transports), for an average speed of 100 km/h, which correspond to the highway or national road trips linked to tourism transportation. Copert III provided results for energy consumption and for nine pollutants: CO₂, CH₄, N₂O (all greenhouse gas), CO, NO_x, COV (light organic compounds), PM (particles), NH₃ as well as the potential of global warming for the 100 coming years (GWP100) which is an aggregated index of the three main gas contributing to greenhouse effect:¹⁵.

Results for the tourism sector were then compared to benchmark values coming from various sources (*Citepa, Commission des comptes des transports de la nation -CCTN, Observatoire de l'énergie, Comité professionnel du pétrole -CPDP*).

2. Estimation of greenhouse gas emissions for a specific travel

The indicators provided by the previous evaluation are quite technical and hard to communicate with on a large scale, towards the general public. They do not insist enough on individual responsibilities towards the greenhouse effect, and do not provide satisfactory information about the implication of the modal choice on greenhouse gas emissions. To present these results in a more attractive way, it was decided to calculate a specific indicator: a comparison of price, energy consumption and greenhouse gas emissions of a Paris to Nice trip, according to the mode of transport (see Figure 5). The indicator was calculated both for a family trip (4 persons), and for an individual trip, during a peak period (influencing prices and load factor). The indicator provides a range (min/max) between the most and the least polluting vehicle for each mode of transport,

¹⁵ GWP100 (in carbon equivalent)= 12/44.(CO₂ emissions + 21. CH₄ emissions + 310. N₂O emissions)

or between the most and least polluting kind of travel (for airplane, a charter flight pollutes less per person, because of better load factor, for instance).

- The Copert III methodology, as explained before, was used for road transport, with a distinction between diesel and petrol vehicles, and precise data about the characteristics of travel (different types of roads, and their respective speed).

- For air transport, data were provided by Airbus industries (Airbus Aircraft performance program) and completed by the Emep/ Corinair simplified methodology for other airplanes. Emissions were calculated for a load of factor of 100%.

- For rail transport, the Jorgensen and Sorenson (1997) methodology was used. Emissions depend on the weight of the train, slope, average speed). French railways provided data for TGV (high speed trains). Average emissions factors for diesel train were collected in Zinger and Hecker (1979). These ancient data are compatible with Jorgensen and Sorenson's results from a sample of European trains. Emissions were calculated for a load of factor of 100%.